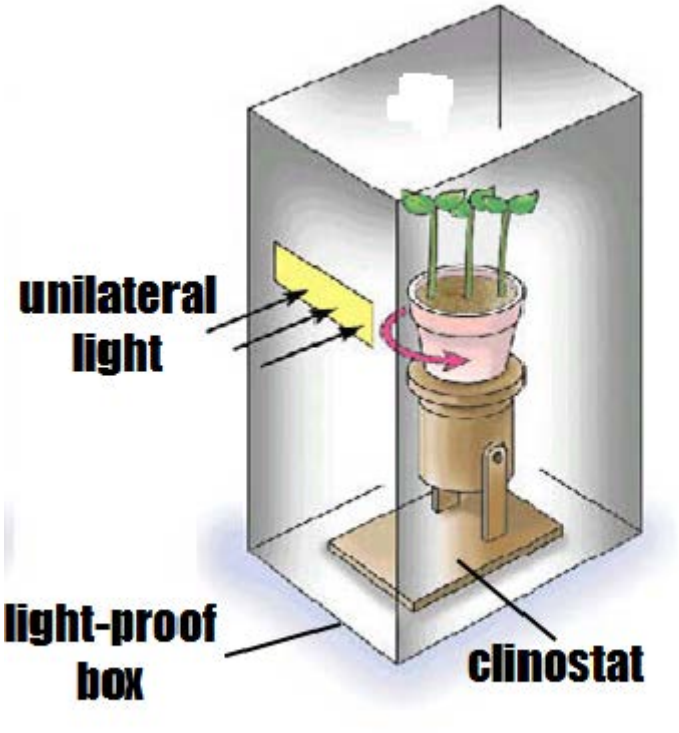
MATRIC SUPPORT

Life Sciences

August 2014

1.1 The diagram below shows an investigation into the effect of light on the growth of a plant. A clinostat consists of a small motor with a rotating platform. A pot plant is placed on the platform as shown in the diagram. Study the diagram carefully and then answer the questions that follow.



Two sets of the apparatus were set up. Plant A had the clinostat rotating and Plant B had a stationary clinostat. Light was shone through the hole in the cover.

1.1.1 Formulate a hypothesis for this investigation. (3)

1.1.2 Mention the independent variable (1)

1.1.3 Mention TWO variables that are fixed. (2)

1.1.4 Explain why two sets of apparatus were set up. (4)

1.1.5 Name the plant response being investigated. (1)

1.1.6 Write down the expected results of each plant. (2)

1.1.7 Name the plant growth substance responsible for the result of the investigation. (1)
[14]

Memo

1.1.1 Plants √ grows towards√ the light√ (3)

1.1.2 the direction of the light √ (1)

1.1.3 the type of plant√/ the size of the hole√ / the size of plants / the size of the pot/ the covering box (any two) (2)

1.1.4 a control and an experiment√ to verify √ that it is the light from the opening √ that let the plant grows towards the light√ (4)

1.1.5 Phototropism√ (1)

1.1.6 Plant A remains growing straight up √ Plant B grows towards the light √ (2)

1.1.7 Auxin √ (1)

QUESTION

Figure 4.7 below shows the stages in the development of the foetus.

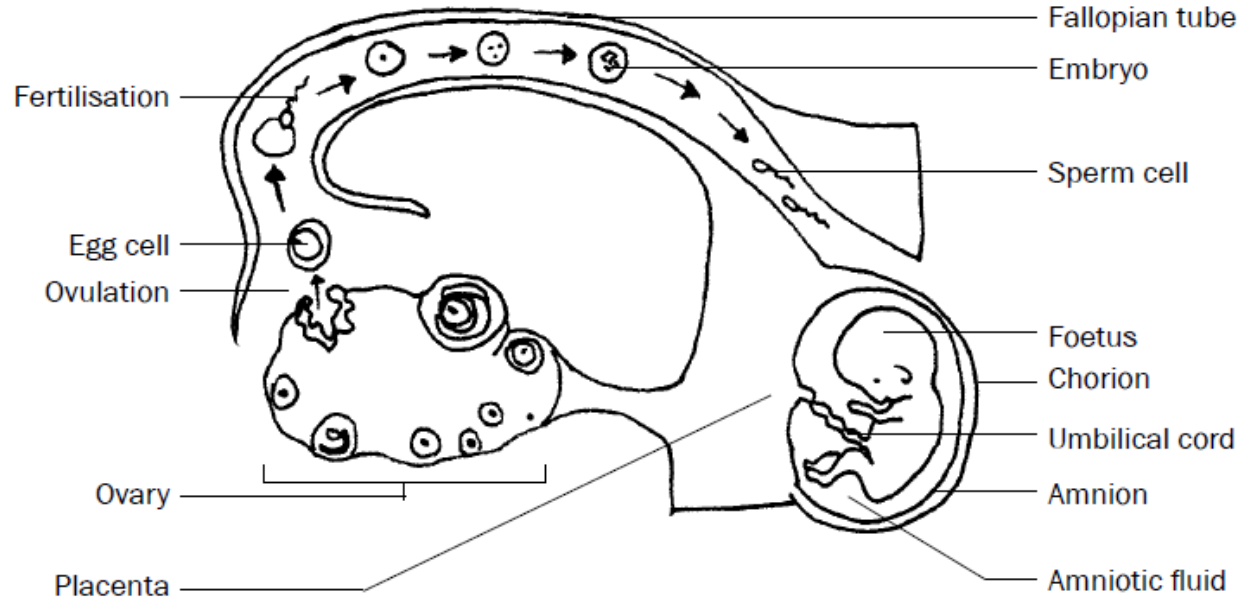


Figure 4.7 Stages in the development of the foetus

Explain the development of the human zygote and the implantation of the blastocyst in humans.

Memo

zygote immediately divides by means of mitosis √ to form two identical√ cells, then four cells, eight cells, and so on until a ball of cells is formed called a morula √ continues to divide and after about 3 – 7 days it reach the uterus, √ it is then a hollow ball of cells √ called a blastocyst which consists of an inner cell mass√ and an outer layer of cells √ /known as the trophoblast √ with a blastocyst cavity. √

The blastocyst remains in the uterus for about 2 to 5 days before it is implanted in the endometrium √ the trophoblast cells secrete enzymes that breaks down the epithelium √ of the endometrium, the blastocyst becomes embedded in the endometrium √ this process is called implantation Due to the actions of
oestrogen and progesterone √ the endometrium is thick and very vascular√

The trophoblast develops finger-like villi (projections) √ that grow √ into the endometrium. These villi together with the maternal endometrium √ form the placenta √ As the blastocyst develops the trophoblast forms several membranes around the embryo√ . – extra embryonic membranes√

As soon as all the organs are differentiated√ the embryo is then called a foetus√ (after the ninth week)

Max (20)

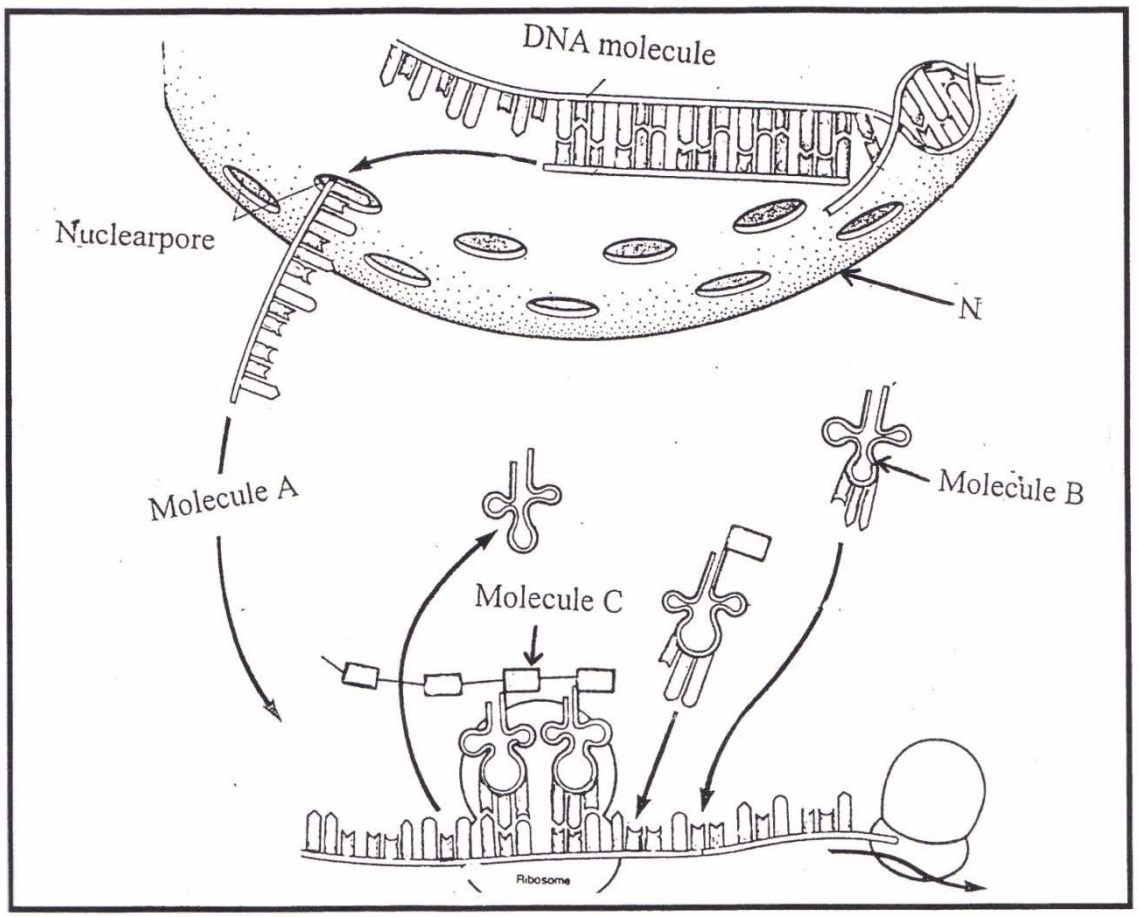
PROTEIN SYNTHESIS

QUESTIONS – to be done before the section

1. What is an amino acid?
2. What is the structure of an amino acid?
3. Where are amino acids found?
4. Name the bonds formed between amino acids
5. Where does protein synthesis occur?

Learning Diagram

Hint: Molecule A is carrying a code out of the nucleus via a nuclear pore.



PROTEIN SYNTHESIS - Cut And Sequence Activity

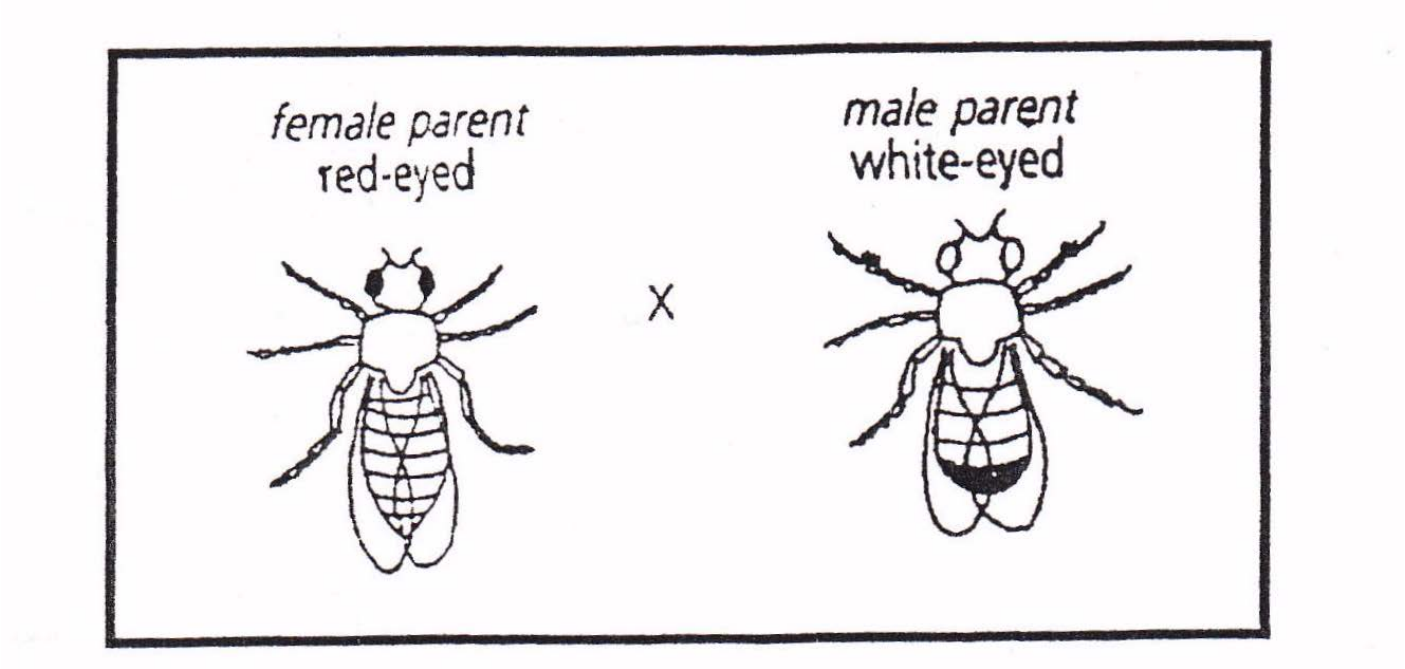
DNA unwinds and splits
One DNA strand acts a template
Free nucleotides arrange to form m-RNA according to the DNA template
m-RNA strand is complementary to the DNA template i.e. A-U; C-G
This process is called **TRANSCRIPTION**

m-RNA moves through the nuclear pore into the cytoplasm and wraps itself around the ribosome
Each t-RNA brings a specific amino acid to the ribosome
amino acids are arranged in a specific order according to the CODONS on the m-RNA
The amino acids are linked by peptide bonds to form a particular protein
The entire process is controlled by **ENZYMES**
This process is called **TRANSLATION**

GENETICS

1. A Problem

In a certain species of fruit fly, the allele for red eyes (represented by R) is dominant to the allele for white eyes (represented by r). A heterozygous female fly was crossed with a male (pictured below):-



Show how the possible phenotypes and genotypes of the F1 generation for eye colour may be obtained by means of a genetics cross. (7)

2. Marking Guideline

P_1 phenotype x ✓
genotype x ✓

Meiosis

G x ✓

Fertilization

F_1 genotype ✓
phenotype ✓

OR

gametes		

P_1 and F_1 ✓
Meiosis and fertilization ✓ max **(7)**

3. Activity: Mark This Pupil's Response According To The Marking Guideline Provided

Pupil's Response

P1	Genotype:	RR	x	rr
	Phenotype:	red	x	white

Meiosis

G	R	x	r

Fertilisation

F_1	genotype:	Rr
	phenotype	only red-eyed flies; red-eyed flies and white-eyed flies

4. Pedigree Diagrams

Steps to follow when completing a pedigree diagram

a. Study any key and opening statement / s provided to look for:-
   i. dominant and recessive characteristics
   ii. phenotypes

b. Write in the phenotype of all the individuals as given in the problem

c. Fill in the genotype of all the individuals with the recessive condition – it has to have two lower case letters

d. For every individual in the diagram that has the recessive condition, it means that each gene was obtained from each of the two parents. So, work backwards and fill in one recessive gene for each of the parents

e. If the parents showed the dominant characteristic, then fill in the second letter which has to be a capital letter

f. Any other individual showing the dominant characteristic will most likely be homozygous dominant (two capital letters)

5. Sex-Linked Inheritance

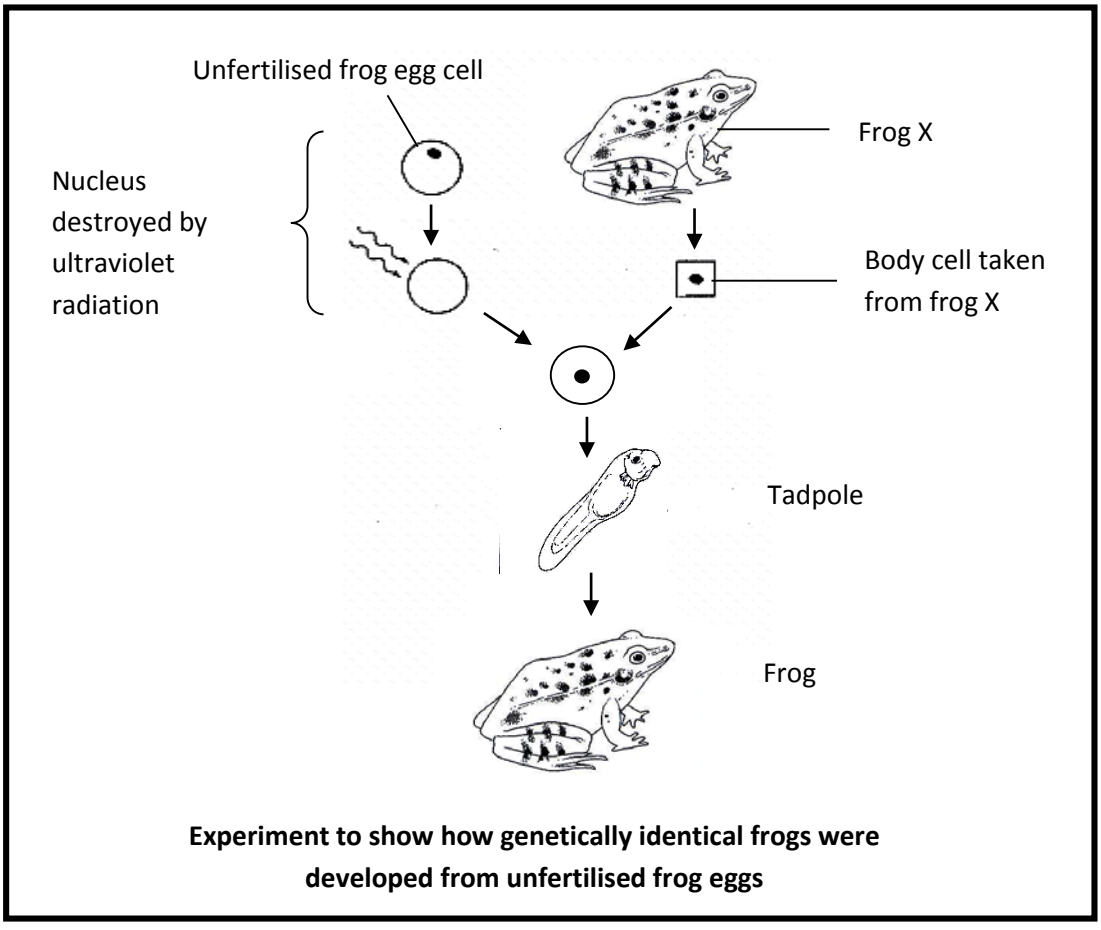
Study the following genotypes and phenotypes which show how colour-blindness is inherited. X and Y represent sex chromosomes.

Individual	Genotype	Phenotype
M	X^BX^B	Normal female
N	X^BX^b	Carrier female. (Does not suffer from colour-blindness but can pass gene for colour-blindness to children)
O	X^bX^b	Colour-blind female
P	X^BY	Normal male
Q	X^bY	Colour-blind male

5.1 Which letter, B or b, represents the gene for colour-blindness?
5.2 Refer to individual N and explain if the gene for colour blindness is dominant or recessive.
5.3 Is the male or the female the carrier of the colour-blind gene?
5.4 What is the name given to the X and Y chromosomes?
5.5 Individuals O and P have a son and a daughter. Show the crosses by using a punnet square to show the genotypes and phenotypes of the children.

CLONING

A 'clone' is a group of genetically identical organisms
Examples: Dolly – sheep; Futi – milk-producing cow; super crops
The Process



Experiment to show how genetically identical frogs were developed from unfertilised frog eggs

- An unfertilized egg cell is used
- with a haploid nucleus
- The nucleus is destroyed
- A diploid nucleus from a body / somatic cell is removed and replaces the haploid nucleus in the egg cell
- This cell now acts like a zygote even though no fusion took place
- The 'zygote' develops into a new organism
- which has all the characteristics of the diploid organism / cell from which the cell was obtained

Advantages of Cloning

- Producing individuals with desired traits (better yield e.g. increased milk production and resistant to diseases)
- Organisms produced in a shorter time
- Could save endangered species
- Could produce body parts for organ transplant
- Produce offspring for organisms that cannot have offspring

Disadvantages of Cloning

- Objection to interfering with God's / Supreme Being's creation / nature
- Reducing the gene pool by reducing variation / Reduces genetic diversity
- Cloned organisms may have developmental / morphological problems
- Costly process
- May generate more experimental waste through unsuccessful cloning
- May lead to killing of clones to obtain spare body parts
- Cruelty to animals

Follow-up: Discuss ways in which cloning and vegetative reproduction is similar and different.

GENETIC MODIFICATION (GM)

GM is a type of technology that alters the genetic make-up of organisms such as animals, plants or bacteria.
Genetic engineering is the transfer of a gene from one organism to another.
Combining genes from different organisms is known as recombinant DNA technology, and the resulting organism is said to be "genetically modified", "genetically engineered" or "transgenic"

1. Genetically Modified Foods

1.1 Some Examples

FOOD	PROPERTIES	MODIFICATION
1. Soya beans	Resistant to herbicides	Herbicide resistant gene taken from bacteria inserted into soy beans
2. Sweet corn	Produces its own insecticide (a toxin to insects, to reduce insect attacks)	Insect-killing gene added to the plant. The gene comes from the bacteria *Bacillus thuringiensis*
3. Rice	Genetically modified to contain high amounts of Vitamin A	Three new genes implanted: two from daffodils and the third from a bacterium

1.2 Advantages of Genetically Modified Foods

a. <u>Crops</u>
- enhanced taste and quality
- reduced maturation time
- increased nutrients, yields and stress tolerance
- improved resistance to disease, pests and herbicides
- new products and growing techniques

b. <u>Animals</u>
- increased resistance, productivity, hardiness and feed efficiency
- better yield of meat, eggs and milk
- improved animal health and diagnostic methods

c. <u>Environment</u>
- 'friendly' herbicides and bio-insecticides
- conservation of soil, water and energy
- bio-processing for forestry products
- better natural waste management
- more efficient processing

d. <u>Society</u>
- increased food security for growing populations

1.3 Controversies / Disadvantages Of Genetically Modified Foods

a. <u>Safety</u>
- potential human health impacts, including allergens

- potential environmental impacts, including unintended transfer of transgenes through cross-pollination and loss of flora and fauna biodiversity

b. Access and Intellectual Property
- domination of the world food production by a few companies
- increasing dependence on industrialized nations by developing countries
- bio-piracy or foreign exploitation of natural resources

c. Ethics
- violation of natural organism's intrinsic value
- tampering with nature by mixing genes among species
- objections to consuming animal genes in plants and vice-versa
- stress to the animal

d. Labelling
- not mandatory in some countries e.g. U.S.A
- mixing GM products with non-GM products confuses labelling attempts

e. Society

- new advances may be skewed to interests of rich countries

VARIATION, NATURAL SELECTION AND SPECIATION

Sources of variation

- Mutation
- Meiosis : - independent assortment / crossing – over
- Random mating
- Chance fertilization

Natural selection

- Most species produce a **large number** of offspring
- Offspring of the same species show a great deal of **variation**
- These offspring **compete** with each other for food, shelter etc.
- Offspring that have **desirable features** for obtaining these resources will survive
- **Nature has selected** organisms with the desirable features for survival
- A large number of offspring will die and only a **small number** of offspring **survive**
- Those that survive, **reproduce** to form the next generation

Speciation

- As a result of a geographical **barrier**
- a population may **split** into two
- The geographical barrier **prevents reproduction** between the two populations
- Each group undergoes **natural selection**
- as a result of varying **environmental conditions**
- and develops **differently** genotypically and phenotypically
- The two populations become so different that they **cannot inter-breed** again even if they mix
- One or both of the populations becomes a **new species**

DARWIN AND LAMARCK

1.
Outline Darwin's approach using an example e.g. giraffe
Darwin

- As a result of genetic variation in the giraffe population
- some giraffes have longer necks than others
- Environmental change/competition for resources occurred

- causing those with shorter necks to die
- and those with longer necks to survive
- since they could reach the leaves of tall trees
- This is termed natural selection
- The genotype for longer necks
- was passed on to subsequent generations
- In this way each subsequent generation had necks longer than the generation before

Outline Lamarck's approach using the same example e.g. giraffe

Lamarck

- All giraffes had short necks originally
- Giraffes frequently stretched/used their necks to reach for leaves of tall trees
- causing their necks to become longer
- The characteristics of long necks acquired in this way
- was then passed on to the next generation
- forming offspring with longer necks than the generation before

2. Tabulate differences between Darwin and Lamarck

Darwin	Lamarck
There was variation in the necks of the giraffe at the beginning (there were short and long necks)	All the giraffes had short necks initially
Genetics causes variation	Environment causes change
Chance occurrence - Environment selected which genes survived	Deterministic - Organism tried to adapt to environment

3. Why is Lamarck's theory not acceptable?

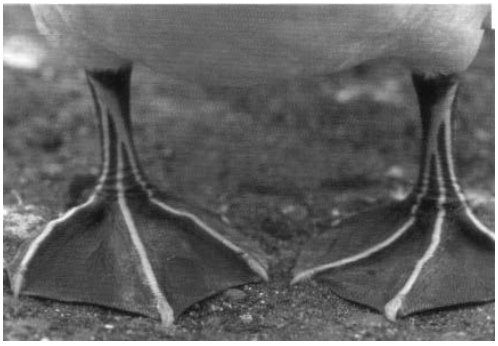
Acquired characteristics cannot be passed from one generation to the next

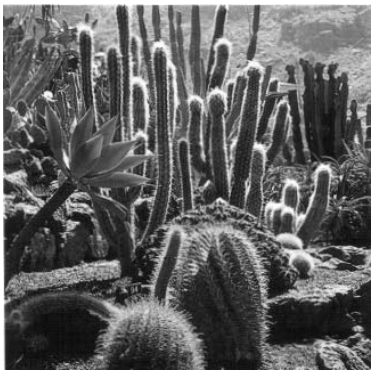
OR

Organisms did not evolve because they wanted to evolve/Lamarck's theory is deterministic

4. Give MANY other examples to illustrate the differerences between Darwin's and Lamarck's theory.

The diagrams below show the webbed feet of a duck and cacti plants.





Explain how Lamarck and Darwin respectively would have explained the …

- webbed feet of the duck
- succulent feature of xerophytic plants.

Webbed Feet

Lamarck

- Lamarck would have stated that ducks initially used their feet only for walking, looking for food on land.

- As food became scare on land the ducks were forced to search for food in the water.
- The ducks tried to stretch their toes apart in an attempt to achieve an efficient swimming stroke
- As a result the skin between their toes became stretched to form the beginnings of the webbed feet.
- This characteristic was then inherited by the future generations.

Darwin

- Darwin would have stated that there was a great deal of variation amongst the phenotypes of the individuals of the duck population
- Some ducks had a little skin attached between their toes.
- As food became scare on land the ducks were forced to search for food in the water.
- Those ducks which had more skin attached between their toes were able to perform a swimming action to secure food from a watery environment.
- Those that were not able to do this died.
- Those that survived reproduced and produced offspring with a large amount of skin between their toes
- Over a period of time the skin became so prominent as found in the webbed feet of ducks today

Question

Describe how the different species of the genus *Proteus* found in South Africa, South America and Australia might have evolved over many generations from an original ancestral population. **[9]**

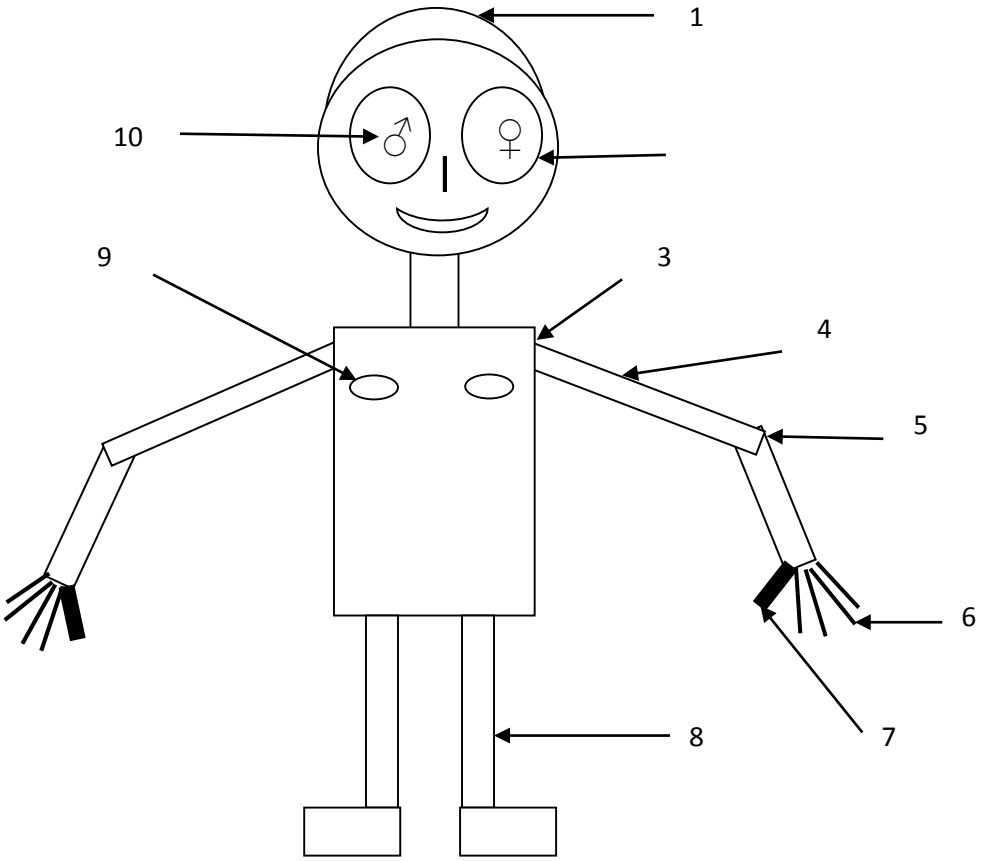
memo

- There was genetic variation✓ within the ancestral *Proteus* populations
- because of continental drift✓
- the landmass consisting of South Africa, Australia and South America split up✓
- separating /geographically isolating populations of *Proteus* ✓/ so that different *Proteus* populations live on three different continents ✓ / South Africa, South America and Australia
- each living under different environmental conditions✓/
- each *Proteus* species underwent natural selection✓ independently on each continent
- those *Proteus* species with the favourable characteristics✓ best suited✓/ on each specific continent survived✓
- over many generations ✓
- and resulted in each continent having species that were very different ✓ (genotypically and phenotypically) from species of the other continent
- which leadi to the formation of new species ✓ on each continent **max** **[9]**

SIMILARITIES BETWEEN *HOMO SAPIENS* AND OTHER PRIMATES

- The following similarities are required by the syllabus

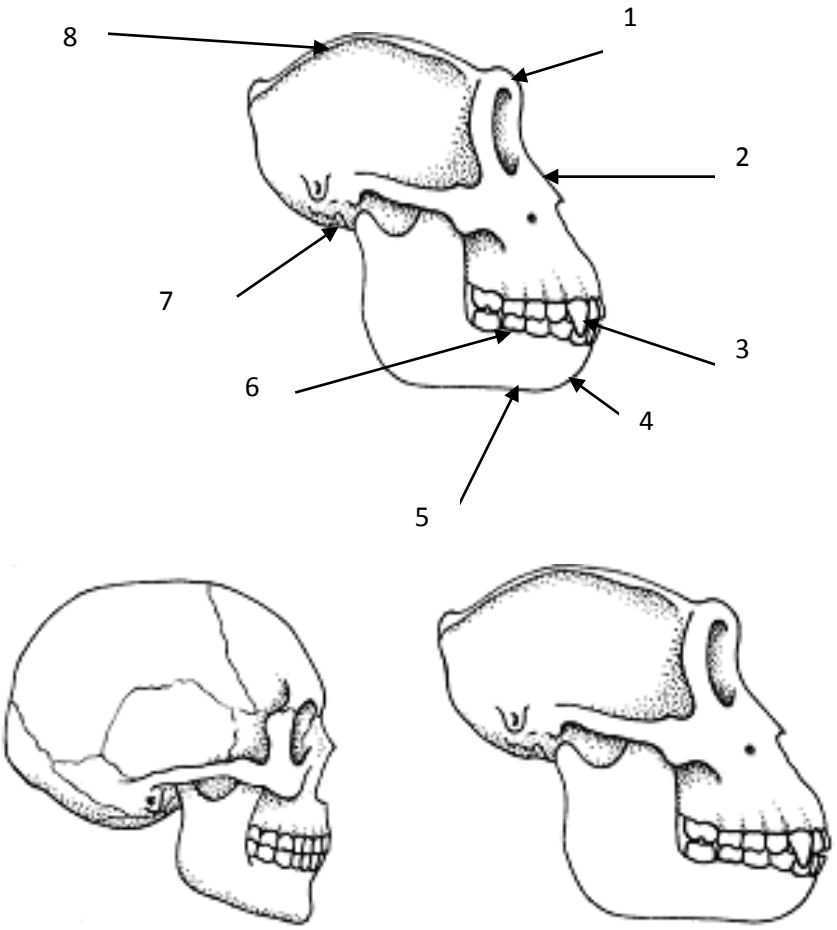
  - Upright posture✓
  - Long upper arms✓
  - Freely rotating arms✓
  - Elbow joints allowing rotation of forearm✓
  - Rotate hands at least 180º✓
  - Flat nails instead of claws✓/bare finger tips
  - Opposable thumbs✓ which work in opposite direction to their fingers
  - Large brains/skulls compared to their body mass✓
  - Eyes in front✓/binocular vision/stereoscopic vision
  - Eyes with cones✓/colour vision
  - Sexual dimorphism✓/distinct differences between male and female
  - Olfactory brain centres reduced✓/reduced sense of smell
  - Parts of the brain that process information from the hands and eyes are enlarged✓
  - Two mammary glands only✓



DIFFERENCES BETWEEN HOMO SAPIENS AND OTHER PRIMATES

- The 2nd and 3rd column below contains the differences that are required by the syllabus
- The differences below relate to the head. To this must be included the posture of the organism (bipedal vs quadripedal) and difference in the development of language.

FEATURE	***Homo sapiens***	***Other primates***
Cranium	1. Larger cranium✓/brain	1. Smaller cranium ✓/brain
Face	2. Flat face✓/ Forehead slope less backwards	2. Face sloping✓/ Foreheads slope much backwards
Foramen Magnum	3. Foramen magnum forward✓/bottom of the skull	3. Foramen magnum at the back of the skull✓
Brow Ridges	4. Brow ridges are not as pronounced✓	4. Brow ridges pronounced✓
Canines	5. Smaller canines✓	5. Larger canines✓
Spaces between teeth	6. Smaller spaces between the teeth	6. Larger spaces between the teeth
Arrangement of teeth	7. Jaws with teeth on a gentle/round curve✓	7. Jaws with teeth in a rectangular/U shape✓
Jaws	8. Less protruding jaws✓	8. More protruding jaws✓/ prognathous
Chin	9. Lower jaw has a well-developed chin✓	9. Lower jaw has poorly developed chin✓



QUESTIONS

Explain evidence from the fossil record that indicates that the Australopithecines were bipedal primates that were also probably ancestral to *Homo sapiens*. **[17]**

Memo

Australopithecus species were bipedal primates

The foramen magnum √ was forward√ *I*not so far than that of humans and head was held vertically √
the pelvis √ more cup-shaped to support the internal organs√
wider sacrum and hips √ to be able to carry the upright weight √ of the body
the spine√ is more curved √ for balance √ keep the centre of gravity √ of the body over the pelvis
lower spine has a greater curvature √ allow free movements of the legs√
foot is stiffened √ to carry the full body weight with the big toe √in line with the other toes√ have arches√ to absorbed shock Max 8

Australopithecus species ancestoral to *Homo*

Transitional form √ characteristics of both genera
intermediate between apes and humans√
Canine teeth were smaller √ than in apes
Relatively unspecialised teeth √ for softer foods√**/** meat
Gaps between canines and incisors were smaller √
Cranium was larger √ than in apes bigger frontal√ brain higher forehead√/
less sloping fore head √
arms were relatively shorter than apes but longer than humans √ and longer √
legs for upright walk
less prognathous than apes√
the palate shape changed to short and broad√ Max 9

[17]

Describe the following:

(a) Punctuated Equilibrium (4)

(b) Artificial selection (4)

(c) Mendel's Law of Segregation (4)

(a) In the 1970's Eldredge and Gould observed that sometimes evolutionary changes √ happen **very rapidly** ✓ / (5, 000 to 50, 000 years) followed by long periods of **stasis** ✓ / (4-10 million years) involving little evolutionary change√ **/** This may happens when a **small portion** of a population is isolated / habitat is destroyed. (4)

(b) humans/ scientists √/ farmers select the desired trait√ breed individuals √ with these traits over many generations √ (4)

(c) An individual has two factors √ for each trait √ and the factors segregate √ /separate into different gametes √ (4)